Application of Natural Jute Fiber in Cement Concrete

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Abstract— As concrete is weak in tension and has brittle character. The concept of using fibers to improve the characteristics of construction materials is very old. Introduction of fibers in disconnected form may provide a solution for the lack of tensile strength in plane and reinforced concrete. The function of randomly oriented fibers is to arrest crack formation and propagation, and thus improving the strength and ductility. As India is one of the largest producers of jute, hence its potential application in many branches of engineering should be developed. The current paper deals with subject of addition of natural fibers to concrete in order to study the strength properties and also to observe if there is reduction in propagation of shrinkage crack problems.

Key words: Cement Concrete, Jute Fibre, Tensile Strength

I. INTRODUCTION

The main concern is to maintain strength of concrete and increase its durability, therefore natural fibers are added which is an economical way to increase strength of concrete. The type of fibers which are generally used includes steel, glass, polymers, carbon and natural fibers. Nowadays, natural fibers are being used as supplementary reinforcement material to overcome the characteristic deficiencies present in cementitious materials. Significant researches are being done for use of reinforcing fibers like jute, bamboo, sisal, coconut husk, sugarcane bagasse etc [1]. in cement composites mostly in case of building materials. Use of natural jute fibers in a relatively brittle cement matrix has achieved considerable strength, and toughness of the composite. The durability of these fibers in a highly alkaline cement matrix have to be considered for effective modifications. A specific chemical composition should be chosen which can modify the fiber surface as well as strengthen the cement composite [2].

Jute is a natural fiber which is obtained from a plant having giant fruits covered with fiber. The soft tissues are then scuffled from the fibers manually or by mechanical means. The fibers are then dehydrated and brushes are removed from the remaining dirt, results in a clean fiber. Jute plant produces sturdy and strong fibers. It is one of the forthcoming reinforcing materials that its use has been verified by experiential means. Jute is the first natural fiber having commercial application. Jute fiber can be used as a natural fiber, for reinforcing cement concrete and also improves resistance to cracks [3]-[7].

This study aims to find the physical properties of conventional cement concrete compared with fiber reinforced concrete which enhance the properties of concrete using fiber by replacing cement with varying percentage of fiber and consequently finding the strength variation in concrete in different mix proportions.

II. MATERIALS AND METHODOLGY

The experimental procedure involves casting and testing of concrete specimens using different ratios of jute fiber (0.5%, 1%, and 1.5%). Average length of the fiber is 4 cm. As the workability is decreased due to addition of fibers found out by after trial and error method of slump test and consistency test, super plasticizers is added to increase the workability.

Review of various literary material is done prior to this study, and the required material is acquired from various sources. Afterwards Cube specimens were cast confirming to the mix design and various test are performed on the specimen. These results are further analyzed and conclusions are derived.

A. Selection and Testing of Materials

In developing the concrete mix for concrete mix for concrete, it is important to select proper ingredients and evaluate their properties. The materials used for this investigation were cement, sand and, coarse aggregate, and water.

1) Cement

OPC 53 Grade conforming to Indian Standard IS 12269:1987 is used as a binder material.

2) Water

Water used for producing and curing concrete should be clean and free from substances like oil, acid, alkali, salt, sugar, silt, organic matter and other elements which are harmful to concrete. Therefore, potable tap water is used in this study for mixing and curing.

3) Fine Aggregate

Sand conforming to Zone-III is used as the fine aggregate, as per I.S 383-1970. The sand is air dried and is found to be free from any foreign material, before mixing. The properties of fine aggregate is given in Table 1.

S No.	Physical properties	Test Result
1	Maximum size (mm)	4.75
2	Specific Gravity	2.63
3	Bulk Density	1530-1600

Table 1: Properties of fine aggregate

4) Coarse Aggregates

Available coarse aggregate of sieved size 20mm are used throughout the work.

S No.	Physical properties	Test Result
1	Maximum size (mm)	20
2	Water absorption (%)	0.50
3	Specific gravity	2.74

Table 2: Properties of coarse aggregate

5) Jute fiber

Fine quality jute fiber is procured from a local supplier in a single consignment.

S No.	Physical properties	Test Result
1	Length (cm)	4
2	Diameter (mm)	1
3	Specific gravity	1.29

Table 3: Properties of Jute Fiber

III. MIX DESIGN

Mix design is the process of selecting suitable ingredients of concrete and determining their relative quantities for producing concrete of certain minimum properties as strength, durability and consistency etc., as economical as possible. The mix design has been done for concrete of grade M 20 and M 25.

IV. EXPERIMENTAL INVESTIGATION

The experiment was conducted using different proportions of fibers.

A. Mix Combination

For present study, jute fiber is added on basis of percentage to conventional concrete.

B. Preparation and Testing Of Specimens

The moulds of size 150 mm×150 mm×150 mm is used to prepare the concrete specimens for determination of compressive strength. All the specimen are prepared according to IS specification.

C. Mixing, and Casting of Specimen

A cautious method is adopted in batching, mixing and casting operations. Weight Batching is accomplished with the help of electronic weighing balance. Batching is done for each of the mix proportions. The concrete mixture is prepared by mechanical mixture. Fiber and cement is mixed thoroughly for better bonding and the coarse and fine aggregates were mixed subsequently. The fresh concrete is placed in moulds in 3 layers, the vibrations are stopped as soon as the cement slurry appeared on the top of the mould.

D. Demoulding and Curing

The specimens are demoulded after 24 hrs with care and are placed in the curing tank at ambient temperature. The ambient temperature for curing is about 27±20 ºC.

E. Compressive Strength Test on Concrete Specimens

Compressive strength can be defined as resistance of concrete to axial loading. The cube specimens are tested for compressive strength at 3, 7 and 28 days on compression testing machine. Three specimens, from each batch are tested for at every age and average of 3 values are taken. The load is increased continuously and without shock. The maximum failure load is recorded and compressive strength is determined.

V. ANALYSIS OF RESULTS

The variation of compressive strength at 3rd days, 7th days and 28th days of the conventional concrete with jute fiber and steel fiber with are shown below. The percentage here shows the amount of jute fibre used.

Specification (%)	Mix Ratio	Density (kg/m^3)	Strength (N/mm²)		
			3rd day	7th day	28th day
cc	1:1:2:0.45	7813	13.52	19.06	29.32
0.5%	1:1:2:0.45	8073	16.57	20.32	35.04
1%	1:1:2:0.45	8111	16.73	21.18	40.44
1.5%	1:1:2:0.45	8055	16.69	22.38	32.03

Table 4: Compressive strength of concrete specimen grade M 25

Specification (%)	Mix Ratio	Demoulded Density (kg/m^3)	Strength (N/mm²)		
			3rd day	7th day	28th day
cc	1:1.5:3:0.5	8110	12.8	18.20	28.44
0.5	1:1.5:3:0.5	8191	13.36	17.74	34.63
1%	1:1.5:3:0.5	8265	16.23	20.66	36.29
1.5%	1:1.5:3:0.5	8182	12.25	17.15	32.31

Table 5: Compressive Strength of concrete Specimen M 20

Specification (%)	Mix ratio	Demoulded Density (kg/m^3)	Strength (N/mm²)		
			3rd day	7th day	28th day
cc	1:1:2 :0.45	1346	1.41	1.80	3.02
0.5%	1:1:2 :0.45	1357	2.127	2.316	3.30
1%	1:1:2 :0.45	1343	1.773	2.132	3.65
1.5%	1:1:2 :0.45	1345	1.858	1.984	3.48

Table 6: Tensile Strength of Concrete Specimen M 25

Specification (%)	Mix ratio	Demoulded Density (kg/m^3)	Strength (N/mm²)		
			3rd day	7th day	28th day
cc	1:1.5:3:0.5	1345	1.29	1.76	2.528
0.5%	1:1.5:3:0.5	1354	1.203	1.58	2.769
1%	1:1.5:3:0.5	1336	1.36	2.094	3.009
1.5%	1:1.5:3:0.5	1337	1.684	1.339	2.896

Table 7: Tensile strength of concrete specimen M 20

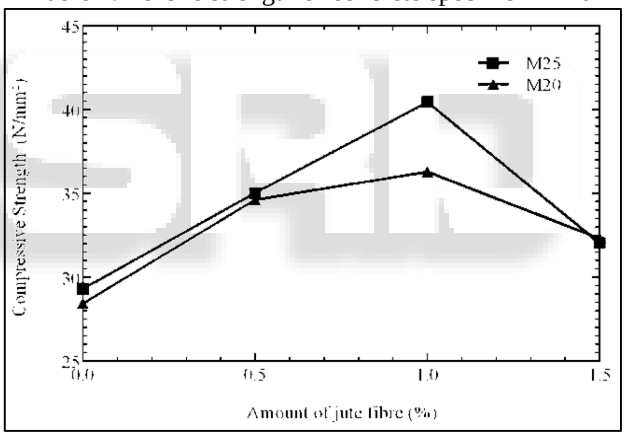

Fig. 1: Compressive strength comparison of jute fibre concrete mixes

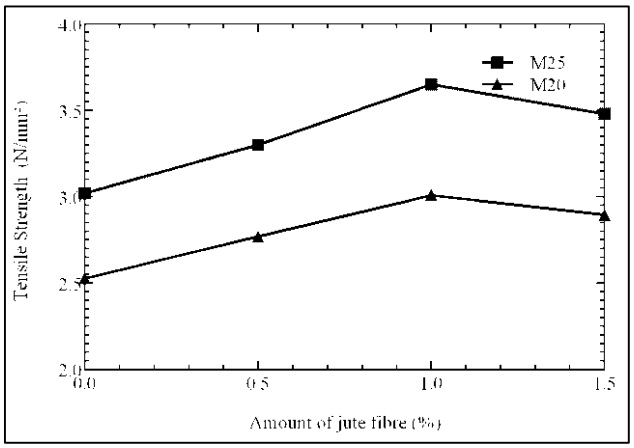

Fig. 2: Comparison of tensile strength for concrete mixes with jute fibre

VI. CONCLUSION

Based on the test results, it can be established that jute fiber infused concrete is better than the conventional cement concrete and also it can also be used for both PCC and RCC, it also act as a crack retarder in concrete and reduces shrinkage effect while enhancing the tensile strength.

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